LOWELL OBSERVATORY, CLARK DOME
1400 W. Mars Hill Road
Flagstaff
Coconino County
Arizona

HABS NO. AZ-206-B

HABS
ARIZ
3-FLAG,
1B-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

REDUCED COPY OF DRAWING

Historic American Building Survey
National Park Service
Department of the Interior
P.O. Box 37127
Washington, DC 20013-7127

HABS
AR-12
3-FLAG,
1B-

HISTORIC AMERICAN BUILDINGS SURVEY

LOWELL OBSERVATORY, CLARK DOME

HABS No. AZ-206-B

Location: Lowell Observatory, 1400 West Mars Hill Road, Flagstaff, Coconino County, Arizona. The Clark dome is located on a slight rise on the east central side of the Observatory site. The front entryway of the dome faces north.

Present Owner: Percival Lowell Estate, Lowell Observatory.

Present Use: The Clark Dome houses a 24-inch refracting telescope used for astronomical observations.

Significance: Designed and constructed in 1896 by Godfrey and Stanley Sykes, the Clark dome is the oldest standing dome at Lowell Observatory. The dome was built to house a Clark 24-inch refracting telescope, one of the first large telescopes in the American southwest. Percival Lowell used this telescope to conduct research on the planet Mars.

Historian: Rebecca Jacobsen, HABS, summer 1994

PART I. HISTORICAL INFORMATION

I. Physical History:

1. Date of Erection: The Clark dome was erected on the Lowell Observatory site sometime in 1896 as a replacement for a temporary dome put up in 1894. The exact date of the Clark dome's completion is unclear, although letters and telegrams from Percival Lowell to Andrew E. Douglass, an astronomer hired by Lowell to select the Observatory site, place the date between September and December of that year.[1]

2. Architect: Godfrey Sykes designed the Clark dome under the direction of astronomers A. E. Douglass and William Pickering. Godfrey Sykes was originally from England, and located in Flagstaff in 1886.[2] He and his brother Stanley opened a machine shop and were known locally as "Makers and Menders of Anything."[3] Both men assisted in observatory building construction and instrument making. Stanley Sykes would remain an observatory employee for forty six years.[4]

3. Original and Subsequent Owners: The dome has been part of the Lowell Observatory since it was built in 1896. The building and the observatory as a whole were owned by Percival Lowell until his death in 1916. Lowell had set aside funding for the continuing operation of the observatory and it is now operated under the "Percival Lowell Estate."

4. Building Contractors/Suppliers: The designer and builder of the Clark telescope dome was Godfrey Sykes, a native of England and Flagstaff resident since the 1880s.[5] He was assisted in construction by Edgar Whipple, one of Flagstaff's first settlers.[6] Lumber for framing the dome was supplied locally, probably by the Arizona Lumber and Timber Company. Dennis Riordan, Lumber Company proprietor, had offered A. E. Douglass lodging during Douglass's site search. "Furniture" inside the dome, including ladders and platforms, was constructed by Godfrey Sykes and Edgar Whipple.

The lens for the dome's telescope, a 24-inch refractor, came from Alvan Clark and Sons of Cambridgeport, Massachusetts.[7] A Brashear spectrograph was purchased in 1900 and installed in 1901.[8] The driving clock for the telescope was built by Stanley Sykes, Godfrey's brother. Stanley Sykes would be an Observatory employee for almost fifty years. Stanley was also responsible for the construction of a short-lived pontoon system for rotating the dome in a water-filled track.[9]

In 1957, the iron wheels on which the dome rotated were worn out. V. M. Slipher, Lowell astronomer and former Director, provided the money to purchase a set of rubber Ford automobile tires to replace the iron wheels.[10]

5. Original plans and construction: What appears to be an early set of blueprints in the Lowell Observatory archives, although undated, suggests that the structure has not changed much since it was built. The blueprints show one large circular room, open to the ceiling, with a fan-like rafter pattern inside the dome. This arrangement exists today.

Early photographs (pre-1900) show the building to have a wooden cylindrical base topped with a dome shaped like an "inverted bucket." Both base and dome were painted white. The entrance was a single, wood paneled door facing northeast, with a simple, unpainted set of wooden stairs.

6. The Clark dome has had no major additions. It has, however, had a number of small alterations:

1896-1900: Pre-1900 photographs show a number of small changes in the exterior fabric of the dome, most of them likely made by Stanley and Godfrey Sykes. Although none of the photographs are specifically dated, the alterations they depict would have been made shortly after the dome was re-erected on the site in 1897 (Fig. 1, Fig. 2). The original canvas dome covering, for example, would have been replaced with a metal covering almost immediately in order to protect

the new 24-inch refracting telescope. Further evidence dating these photographs to pre-1900 is the appearance of the small workman's cottage in the background. This structure was constructed in 1894 and was added on to first in 1901, then again in subsequent years, to serve as Percival Lowell's private residence.[11] The structure appears in the photographs without these additions.

The early alterations to the Clark dome, in estimated chronological order, include:

Canvas dome covering replaced with thin sheet metal.
Top canvas observatory door replaced with a metal faced wood door.
Bottom canvas observatory door replaced with a metal faced wood door.
Wood vertical slat foundation covered with shingles.

1899: Stanley Sykes experimented with a method for rotating the dome on wood pontoons in a water filled track. Notes in Lowell archives entitled "A Diary of Floating the Dome" describe the progress of the project. Work began in February 1899, and an entry dated May 10 noted, "Leaks all stopped (or nearly). Pontoons in and at 4:30 enough water in trench to float dome. Turned once around." The pontoon system worked, but caused problems in winter when the water in the trench froze. The system was quickly removed (date unknown) and traditional metal wheels were put back in place.[12]

1937: Wood building foundations were redone in concrete. These footings were repaired in 1990. The foundations are currently faced with malpais volcanic rock and match other observatory buildings.[13]

1957: The old metal wheels for rotating the dome were replaced with new, rubber tires. These tires, in place in the dome today, were from the Ford Motor company and came complete with hubcaps. The tires were purchased with funds donated by Vesto Melvin Slipher, Lowell astronomer and observatory Director after Percival Lowell's death.[14]

1985-1994: Some minor alterations have been made to better accommodate visitors to the Clark dome. Most of these alterations have been done by Lowell maintenance man Gerald McGlothlin. These alterations include:

Glass panes added to the north east door of the dome, date unknown.
Removal of a small, curvilinear portico from the north east entrance door in 1988 and re-installing it over the south

door in 1991.
Construction of a wood, end gabled portico with two wood columns over the north east door in 1988.
Construction of a concrete ramp with tubular metal rails around the eastside of the dome, from the north east door to the south door in 1994.[15]

B. Historical Context:

The construction of a telescope dome on Mars Hill in 1894 marked the beginning of many years of astronomical study at Lowell Observatory. The Observatory, founded by wealthy Bostonian Percival Lowell, was unique among nineteenth century observatories in a number of ways. Its mountain top location as opposed to traditional placement near a university, for example, reflected a growing knowledge of the effects of atmosphere on observing.[16] Lowell's pattern of housing telescopes in individual buildings instead of all under one large roof was likely a product of the initial temporary status of the Observatory as well as the difficulty of getting building materials to the top of a mountain in frontier Arizona, yet it was a precursor to the layout of observatories in the twentieth century.[17] Even Lowell's emphasis on the study of the solar system was unusual among contemporary observatories as most other observatories all over the world devoted themselves to studying the stars.

Perhaps the most visual difference between Lowell and other late nineteenth century observatories was the shape of Lowell's domes. Rather than the traditional hemispherical shape, some of the domes at Lowell were built in an "inverted bucket" shape.[18] The first dome to be built in this shape was the 24-inch Clark telescope dome.

The 24-inch Clark Dome

The dome of the 24-inch Clark refracting telescope is the oldest existing telescope dome at the Lowell Observatory in Flagstaff, Arizona. Built of local materials by local contractors, the Clark dome's unique "inverted bucket" shape made it quite unlike contemporary domes such as the 1888 Lick Observatory dome on Mt. Hamilton, California, or the 1895 Yerkes Observatory dome in Williams Bay, Wisconsin, each of which have a hemispherical dome.[19]

The odd shape of the dome may be attributed to its designer, Godfrey Sykes. Sykes, a native of England and Flagstaff resident since 1886, was an expert with all things mechanical. He and his brother Stanley operated a shop in Flagstaff, and were known locally as "Makers and Menders of Anything."[20]

In 1896 Sykes was approached by Percival Lowell to design a new 40' telescope dome for the Observatory to replace a smaller, temporary dome that had been built on the site in 1894.[21] Sykes agreed to the project but was a bit hesitant since he had never designed such a structure before. In his memoirs, Sykes described his dilemma:

> I asked him [Lowell] for more explicit instructions as to the details because, as I explained, the building of astronomical domes had not hitherto been one of my more common forms of activity. He replied that as we claimed to be competent makers of anything, that of course covered the case and settled the matter. He deemed it to have been a concession upon his part to have mentioned the diameter of the structure which he wished for and further discussion concerning details was clearly unnecessary.[22]

Sykes was not entirely unfamiliar with domes as he had been asked to help correct dome rotation problems with the early, temporary dome. He turned to Andrew E. Douglass, Harvard astronomy professor and Lowell's "chief of operations" at the Flagstaff site, for instruction on dome rotation. In a January 1895 letter to Percival Lowell, Douglass wrote, "Have finished an article on 'The Dome Telescope,' a combination of a spherical dome and telescope . . . But I can't get enough books of reference to settle some of the questions raised by Sykes, chief among which is the power required to set in motion a spherical shell weighing 300 to 400 tons . . ."[23]

In the end, the new design was Sykes's own. As he described it in his memoirs, "It was to be constructed of timber, framed as lightly as possible in order not to retain an undue amount of heat after sunset . . . so what finally emerged from my brainstorms . . . was a structure like a huge inverted bucked, surmounted by a flattish conical lid."[24] With the help of Flagstaff resident Edgar Whipple, Sykes was able to put the Clark dome together in the last several months of 1896.[25] There was considerable pressure to erect the dome quickly as Lowell needed the dome to house the new 24-inch refracting telescope he ordered from the famous instrument makers Alvan Clark and Sons of Cambridgeport, Massachusetts. The telescope was due to be completed June 1, 1896, and Lowell intended to use both telescope and dome to make observations of Mars during the upcoming "favorable opposition."[26] Yellow pine was used to frame the dome as it was locally available and could be gotten quickly. According to Sykes, the bucket shape of the dome was a concession to the poor quality of the framing materials. Sykes did not feel that pine could not support a traditional hemispherical dome.[27]

Interestingly, the Clark dome was being constructed at a time when Percival Lowell was having second thoughts about keeping the Observatory in Flagstaff. In 1894, the year Lowell sent Douglass to the southwest to search for suitable sites, Flagstaff had provided the best "seeing" in Arizona. William Pickering, a Harvard colleague of A. E. Douglass, designed a temporary, portable dome and had it shipped to the Flagstaff site.[28] Douglass, Pickering, and Lowell began making observations that summer with the temporary dome and two borrowed telescopes. However, during the next two years, the seeing quality was much poorer, and the winter of 1895 was so cloudy and snowy that Douglass, the only member of the group to remain in Flagstaff in the winter, was only able to observe the sky for a few days.[29] On March 5, 1895, Lowell wrote to Douglass from Boston regarding the future of the Observatory. He wrote, "The seeing seems to be so perpetually poor now that I see little use in keeping up the observatory longer. . . . My plan at present is to find another site for the opposition and to ship the dome as it is to wherever that may be. . . ."[30]

Douglass ceased making observations in Flagstaff on April 3, 1895.[31] Lowell suggested Mexico City as a possible alternative site, and shortly after, Douglass traveled south to test the "seeing" at various points in Mexico.[32] The alternative observatory site finally selected was Tacubaya, Mexico, and the move took place in November 1896.[33] Sykes and Whipple, aware of the intended move, constructed the new dome so it could be taken apart and easily shipped to its new location.[34] In December 1896, Douglass and Sykes, with the help of local laborers, were hard at work re-constructing the dome at the nex site in Mexico. By the end of the month, Percival Lowell himself arrived in Tacubaya with the new Clark telescope.[35]

During the winter of 1896-97 the dome and telescope were used in making observations of Mars, studying the atmosphere and its effects on observing, and studying the planets of Mercury and Venus.[36] While the observing in Mexico was satisfactory, Lowell decided to move back to the Flagstaff site in the spring. Lowell apparently felt that the quality of observing was no better in Mexico than it had been in the Arizona Territory, and further, the political climate was much more stable in the United States. By April 1897, the dome was back in Flagstaff being assembled again on the mesa west of town. The telescope arrived the first week in May, at which time permanent, regular observations began.[37]

Making Observations

Unfortunately, Lowell was personally unable to resume his observations of Mars as he suffered from a bout of "nervous exhaustion" upon his return from Mexico.[38] This condition kept him from his work for the next four years. Lowell's illness was particularly poorly timed, as members of the astronomy community had begun to react to Lowell's publishings on his 1894 Mars research.[39] Lowell had been interested in Mars since the 1870's when Italian astronomer Giovani V. Schiaparelli announced his discovery of canali on the surface of the planet. Canali, which should have been translated as "channels" was erroneously interpreted as "canals," and very quickly the mis-interpretation grew even larger as some assumed that intelligent life was necessary to create such canals. Lowell was one who strongly believed in life on Mars and much of his research was carried out to prove that life (though not necessarily human life) existed on that planet.[40] In fact, Lowell founded his observatory with the intent to study Mars in detail.[41]

The observations Lowell made during the summer of 1894, the first summer of observing in Flagstaff, led to a series of lectures and a number of publications touting his belief in life on Mars. His theories and writings were questioned by a number of prominent astronomers, notably Lick Observatory astronomers Edward S. Holden and W. W. Campbell, and a public debate ensued. Lowell was accused of making extreme claims without having compiled enough research to back up his revelations. Others suggested that since Lowell was the only one to see the things he claimed to have seen, perhaps his telescope lens was faulty. In any case, Lowell's "nervous exhaustion" kept him from making new observations, the very thing he needed to find further proof to substantiate his claims.[42]

Mars was not the only object of study at the Lowell Observatory. Lowell and his staff also turned the telescope towards Venus, and again, Lowell's "discoveries" caused a great deal of argument. Venus has always been difficult for astronomers to study due to the planet's heavy cloud cover. Surface features remained indistinct even when viewed through the best telescopes under ideal conditions. Lowell, however, claimed to see some interesting detail. This detail allowed him to calculate the rotation period of the planet. Once again, Lowell's calculations were in conflict with those of other astronomers and the result was yet further controversy.[43] As with the Mars debates, Lowell's health kept him from doing the research necessary to support his theories.

Interestingly, it was the debate over the rotation of Venus that brought on the next phase of Lowell Observatory research and prompted an important addition to the Clark dome. Lowell needed a second method to calculate the rotation of Venus to back up his earlier findings. Realizing that "spectrography"[44] could be helpful in making such calculations, Lowell arranged to have instrument-maker John A. Brashear make a spectrograph for the Lowell Observatory.[45] The instrument, which would be mounted with the 24-inch Clark telescope, arrived at roughly the same time as a new assistant at the Observatory: Vesto Melvin Slipher.[46] In time, Slipher would become an expert with the spectrograph. He used it not only to conduct planetary research for Lowell, but in his own studies of stars and spiral nebulae. Slipher's work with spectrography led to one of the most important discoveries in astronomy. By studying the spectral lines produced by the Andromeda and Virgo nebulae, Slipher determined that the nebulae were moving away from the Earth. This discovery would lead to the current theory that the universe is expanding.[47]

"A Diary of Floating the Dome"

While observations went on inside the Clark dome, a few changes were being made to the exterior. As the dome moved from temporary status to permanent status, the exterior fabric changed. A number of photographs taken by A. E. Douglass document these changes. Between 1897 and 1900, the original canvas covering on the dome was replaced by thin sheet metal. Next, wood and metal observation doors were built first on top of the dome, then on the side. In addition, shingles were placed around the wood foundations.[48]

Perhaps the most radical change in the Clark dome was made in 1899. In that year, Stanley Sykes, brother of dome designer Godfrey Sykes, tackled the significant problem of making the heavy Clark dome rotate smoothly. A. E. Douglass and Godfrey Sykes had run into problems making the first dome, the 18-inch temporary telescope dome, rotate. In fact, when the temporary dome was first put together, the wheels were not aligned properly and the dome would not rotate at all. It then had to be completely taken apart and half the wheels re-set.[49] In 1895, when Douglass and Godfrey Sykes first discussed dome rotation, an interesting solution was touched upon. Douglass mentioned this solution to Lowell in a January letter. He suggested that the dome would "float in water."[50]

The "floating dome" idea was not original to Godfrey Sykes. In the 1880s, Gustave Eiffel, the famous French engineer, proposed a similar system for the Bischoffsheim Observatory in

Nice, France. Cannonballs had been previously used to rotate the domes, but this method required perfectly level ground or the dome would not rotate easily. According to Marian Donnelly in the book A Short History of Observatories, Eiffel "suggested that the dome have a box at the bottom which would float in a tank of corresponding shape and filled with water or some other fluid. . . . The fluid chosen was a solution of chloride of magnesium, which would not be expected to freeze at temperatures above -40 degrees C."[51] It is likely that Andrew Douglass gave Godfrey Sykes reading material on the subject.[52]

In 1899, Stanley Sykes set about to try this method. He began working on a way to "float the dome" using wooden pontoons in a water-filled track. Originally, the dome moved via a set of small, iron wheels on a hardwood track. Sykes's plan called for the removal of the wheels and the construction of a tin-lined trench in place of the hardwood track. The trench would be filled with water and a number of hollow, wood pontoons with the dome resting on top were to be floated in the trench. Sykes's notes on the project also called for some sort of tank and trough, presumably for maintaining the water supply in the trench.[53]

Sykes's notes from June 1899, entitled "A Diary of Floating the Dome" chronicle the construction process. According to the notes, work began in February 1899. The pontoons themselves were constructed first, with lumber arriving on the 14th or 15th of the month. By the middle of March, Sykes was busy removing parts of the "gallery," an narrow interior catwalk, and putting in the bottom of the trough. The original track was removed and by March 31, Sykes and assistant Harry Hussey began to line water holding parts with tin.[54]

On April 22, Sykes noted that the "Tank [was] built and door to trench built. Tin also put inside trench . . ." He further stated that "Water for testing trench comes up [to] 500 gal." The final entry of the "Diary," dated May 10, 1899, said, "Leaks all stopped (or nearly). pontoons [sic] in and at 4:30 enough water in trench to float dome. Turned once around."[55]

As novel as the floating dome idea was, it would cause serious problems in Flagstaff's cold winter months. The water in the trench would freeze, undoubtedly damaging the pontoons and the trench itself. The pontoon idea had to be abandoned and the original iron wheels replaced. The exact date of the pontoon removal is unknown, however they were certainly gone by 1905. A photograph taken inside the dome in that year shows the

original iron wheels back in place.[56] Today, the only reminders of the short-lived pontoon system are the water stains on the interior walls of the dome just below the site of the trench.[57]

Continuing Research

By 1901, Lowell's health was restored and he was back at the Observatory searching for evidence of life on Mars. The Clark dome and its 24-inch telescope were in almost constant use. Lowell was joined in Flagstaff by several new assistants, who would distinguish themselves with the mastery of new observing techniques and their own subsequent discoveries. V. M. Slipher's work with spectrography and spiral nebulae continues to have an impact on astronomical studies today.[58] Carl Otto Lampland, an astronomer who joined the Lowell staff in 1902, made significant breakthroughs in planetary photography, a fledgling field at that time.[59] Also important during this time was the initial search for a "trans-Neptunian planet," a planet beyond Neptune. Lowell searched for this planet unsuccessfully up until his death in 1916.[60] In 1923, Constance Lowell, Percival's widow, had her husband's mausoleum erected next to the dome where he had done so much of his research.[61]

With few exceptions, the 24-inch telescope and its dome saw almost continuous use from the completion date in 1896. For a period of several months in 1906, the telescope was unused as the telescope lens was being refigured. Another short break in the ongoing use of the dome occurred in 1957. In that year, the iron wheels that the dome rotated on had to be replaced. Instead of iron wheels, the new wheels were rubber automobile tires. Purchased with money donated by V. M. Slipher, the tires came from the Ford Motor Company. These tires, each with a shiny silver toned hubcap, are still in place in the dome today.[62]

As the staff of the Observatory grew and the workload increased, more specialized equipment was needed for specific studies and other telescopes and domes were erected at Lowell Observatory. In 1909, a dome for a new 40-inch telescope was built.[63] In 1929, a telescope dome was built to house the A. Lawrence Lowell telescope, the 13-inch telescope that was instrumental in the discovery of Pluto.[64] Interestingly, the "Pluto dome," as this small dome became known, was a miniature version of the Clark dome. According to V. M. Slipher, the staff opted to use the same style of dome as, "That works and it is much easier to duplicate it than to design and build something different . . . ." Furthermore, Slipher noted that a similar design, ". . . will give something good for less

money than the hemispherical type."[65]

With new telescopes at Lowell Observatory and the establishment of a "dark sky" observing site at Anderson Mesa in the late 1950s, use of the Clark 24-inch refractor slowed down considerably. However, in the 1960s with a renewed interest in our own solar system due to the cold war "space race," the Clark dome saw extensive use once again. The 24-inch refractor was enlisted in a moon mapping project conducted by the Aero Chart and Information Center, a group affiliated with the United States Air Force.[66]

In the 1990s, the use of the Clark dome and telescope has tapered off for research purposes. However, it sees extensive use from the Observatory's evening visitors. It has not been retired from astronomical research and according to Robert Millis, Observatory Director, the optical quality of the telescope is still quite remarkable and the telescope may be called into service at any time.[67]

The Clark dome and telescope were nominated to the National Register of Historic Places in December 1965, and they are popular attractions with visitors to the Lowell Observatory. Visitors see the Clark dome and 24-inch telescope in much their original form as only a few changes to the exterior have been made to accommodate visitor traffic. A concrete sidewalk with railings and footlights now passes around the west side of the dome. A gabled portico was added in 1988 to the north door to protect the entrance from winter icicles. In addition, two of the panels in the north door were replaced with glass to allow visitors to see inside when the dome is closed.[68]

PART II: ARCHITECTURAL INFORMATION

A. General Statement:

1. Architectural character: The Clark Dome was the second dome built at the Lowell Observatory. It was constructed in 1896 when Percival Lowell decided to establish a permanent Observatory in Flagstaff, Arizona, after a successful series of Mars observations there in 1894. The Clark Dome houses the famous 24-inch Clark Refractor Telescope, which was designed and built by Alvin Clark and Sons of Cambridgeport, Massachusetts. The dome structure was designed and built of local materials by a local craftsman. It is a utilitarian structure, and its shape is unusual for an astronomical dome. Unlike contemporary domes, such as the 1888 Lick Observatory dome in California or the 1897 Yerkes dome

in Wisconsin, both of which are hemispherical in shape, the Clark dome is shaped like an "inverted bucket."

2. Condition of fabric: The dome structure is in good condition.

B. Description of Exterior:

1. Overall dimensions: The Clark Dome is approximately 40' in diameter and 40' high. The building is cylindrical, and consists of a base, first floor, and dome in the shape of an "inverted bucket." There are two first floor doors on opposite sides of the base, one with a gabled porch and the other with a smaller porch. The dome rotates on an inside track and has large doors that open on the dome sides and top.

2. Foundations: The earliest photographs of this building show foundations of vertical wood slats and later photographs show the foundations covered with a layer of wood shingles. In 1937, the Clark dome was given concrete foundations. Today, these foundations are covered with a veneer of local Malpais volcanic rock.

3. Walls: The walls of the lower half of the building are sided with narrow, vertically placed strips of wood painted white. The dome is covered with raised seam metal painted white.

4. Structural systems: Both the base and the dome have a frame of local ponderosa pine.

5. Porches, stoops, etc.: According to early photographs, the north facing main entrance door once had a simple set of wood steps. Now this entrance has concrete steps leading to a front gabled portico with two simple side columns. The south facing back door was originally plain, but now has a small, square concrete stoop and a small curvilinear, wooden hood over the doorway. According to Observatory Director Robert Millis, the back hood was once over the main north facing door.

6. Openings:

a. Doorways and doors: There are two doorways; the main door faces north and the back door faces south and slightly west. The north door is six-paneled, with the center pair of panels removed and panes of glass inserted to allow visitors to see

inside the dome. The original door, as seen in early photographs, was also a six-paneled door, but with a slightly different configuration. Evidence suggests that the door opening was larger, perhaps having double doors. Photographs, however, show no doors other than single doors. It is possible that this opening had to be enlarged to allow telescopes and other large equipment into the dome.

The back door is similar to the front door without the glass panels, and like the front door, it is not original. Photographs show the original door to have been made of narrow strips of wood, similar to wainscot, making it blend in with the rest of the siding. The outlines of three large triangular hinges are visible just to the right side of the door. This doorway is a later addition as it does not appear in the earliest photographs, or in a later photograph taken with the construction of the Administration Building in the background. Since the Administration Building was constructed in 1916, the doorway was added some time after that.

There is another small door just right of the side observation doors on the side of the dome. This door is not full size and corresponds with an interior catwalk. The outside is covered with sheet metal like the rest of the dome. (Observation doors are described in the Mechanical equipment section).

None of the doors have door frames.

b. Windows. There are no windows or window frames in the structure.

7. Roof: The roof is shallow, conical in shape, and is covered in sheet metal like the rest of the dome. The frame is wood. Around the outer edge of the dome roof is a short metal railing.

C. Description of Interior:

1. Floor plan: The interior of the Clark Dome is circular, with a circular center pit approximately 12 to 15′ wide, with two rings of deep steps. The telescope mounting is placed just south of the center of the pit, and it and the telescope nearly fill the pit. The room is open to the top of the dome. There is a small catwalk with a wooden ladder on the south side of the room where

the first level of the building meets the dome (Fig. 3).

2. Flooring: The floors inside the dome are made of 2" strips of wood that appear to be oak. On the main floor the boards run east to west. Inside the pit the boards run north to south. The floors do not appear to have a finish.

3. Wall and Ceiling finish: The interior walls below the dome are covered with wainscoting, laid horizontally in panels. A number of odd shaped, irregularly placed cupboard doors are cut into the wainscoting all around the room. The wood inside the dome walls is laid diagonally with an elaborate network of cross bracing. The ceiling consists of the exposed wood framing structure of the dome. The wood strips that make up the ceiling are arranged like those of the dome walls, with the cross bracing fanning out from the center.

4. Decorative features and trim: There are a number of odd sized, rectangular, randomly placed cupboards built into and flush with the walls along the first level of the dome. Each of the cupboards is shallow and some have shelving. A number of them still contain old astronomy equipment.

5. Hardware: On the various odd cupboard doors around the first level of the room are a variety of hinges and latches. Some hinges are rectangular, others are a fancier butterfly shape. The latches include a round, oval, or "T" shaped knob that moves a sliding bolt. The doorknobs on the north facing main door are round metal on a rectangular plate. The door handle on the south facing back door is an iron norfolk latch with a curved, flat band handle and thumb latch.

6. Mechanical equipment: To allow the dome to move in a circular fashion, it has wheels which run on a hardwood track atop the first level. The current wheels are rubber 1957 Ford tires complete with hubcaps (except for one missing one). These were purchased with money left the Observatory by astronomer and former director, V.M. Slipher. Prior to the Ford tires, the dome rotated first on small metal railroad wheels, then on wood pontoons on a water filled track. The water filled track was abandoned when the staff experienced problems with winter freezing. The inside walls of the dome still show water damage from the track. The dome movement is powered by three small motors placed around the track.

There are two sets of rectangular observation doors. One set is on the side of the dome, extending from the roof edge to the dome bottom. The other set extends from the top edge of the first set, just past the center of the dome. Both sets of doors are opened from inside the dome. The top doors are opened with ropes and pulleys, and the side doors have been mechanized.

7. Original furnishings: The Clark Dome includes a number of original furnishings, most notably the black windsor chair from Lowell's Baronial Mansion. Percival Lowell used a similar chair in making observations. (The original chair is broken.) The chair rests on a movable wood platform in the center of a wide ladder assembly on wheels. This ladder reaches to the dome track. In early photographs, this ladder did not have the center mechanized platform, but had flat, step-like rungs its entire 7' width. This ladder allowed astronomers to reach the telescope eyepiece no matter which direction the telescope was pointed.

East of the telescope mounting is a mission oak desk and matching chair, also used early in the dome's history. The desk is interesting as the top drawer runs the full width of the desk, and when opened, has a wood board across the drawer opening. This provides a larger working surface. The wood board removes to reveal storage space below.

The 24-inch Clark refractor is still housed in this building, and other equipment such as the 1901 Brashear spectrograph are still at the Observatory.

D. Site

1. Historic landscape: The Clark Dome rests on a rise on the east central side of the observatory site. It is situated south east of the Administration Building and south west of the 'old library,' which was once Lowell's home.

PART III. SOURCES OF INFORMATION

A. Architectural Drawings: There is an undated set of blueprints for the Clark dome framing structure in the Archives of the Lowell Observatory, Planetary Research Center, Flagstaff, Arizona. These blueprints are currently uncataloged.

B. Early Views: There is an extensive set of early photographs of the Clark dome, both interior and exterior views, in the Archives

of the Lowell Observatory, Flagstaff, Arizona. These photographs are stored in photo album number one, located in the basement vault of the Administration Building. The photographs depict the building from 1896 through the early twentieth century. A partial list of the photographs in the archive is as follows:

The Clark Dome with its canvas covering
The Clark Dome with canvas observing doors
The Dome exterior with new doors and metal sheathing
The Clark Dome with the workman's cottage in the background
The Dome interior showing the new 24-inch refracting telescope
The Brashear Spectrograph attached to the 24-inch telescope
Andrew E. Douglass at work with the telescope
Percival Lowell's chair and observing platform
The construction of the pontoon rotation system in 1899
Staff members inside the dome in 1905

C. Interviews:

Robert Millis, July 16, 1994, Lowell Observatory, 1400 W. Mars Hill Road, Flagstaff, Arizona, Observatory Director.

Gerald McGlothlin, July 1, 1994, Lowell Observatory, 1400 W. Mars Hill Road, Flagstaff, Arizona, Observatory Groundskeeper.

Kathy Kramer, may 31, 1994, Lowell Observatory, 1400 W. Mars Hill Road, Flagstaff, Arizona, Observatory Public Relations Specialist.

D. Bibliography:

Butowsky, Dr. Harry A. Astronomy and Astrophysics National Historic Landmark Theme Study. Washington, D.C.: National Park Service, 1989.

Cline, Platt. Mountain Town: Flagstaff's First Century. Flagstaff, Arizona: Northland Publishing, 1994.

Donnelly, Marion Card. A Short History of Observatories. Eugene, Oregon: University of Oregon, 1973.

Hoyt, William Graves. Lowell and Mars. Tucson: The University of Arizona Press, 1976.

Letters of Andrew E. Douglass, 1894-1897. Archives, Lowell Observatory, Flagstaff, Arizona.

Letters of Percival Lowell, 1894-1897. Archives, Lowell Observatory, Flagstaff, Arizona.

McAlester, Virginia, and Lee McAlester. A Field Guide to American Houses. New York: Alfred A. Knopf, 1992.

Pickering, William. "Facts Pertaining to the Arizona Expedition: March 1, 1894." MS. Uncataloged papers. Archives, Lowell Observatory, Flagstaff, Arizona.

Putnam, William Lowell. The Explorers of Mars Hill: A Centennial History of Lowell Observatory. West Kennebunk, Maine: Phoenix Publishing, 1994.

Slipher, Vesto Melvin. Letter to Roger Lowell Putnam. 3 December 1927. Vesto Melvin Slipher letters. Archives, Lowell Observatory, Flagstaff, Arizona.

Sykes, Godfrey. A Westerly Trend. Tucson: Arizona Pioneers Historical Society, 1944.

Sykes, Stanley. "A Diary of Floating the Dome." Uncataloged papers. Archives, Lowell Observatory, Flagstaff, Arizona.

PART IV. PROJECT INFORMATION

The Lowell Observatory Recording Project was sponsored by the Arizona State Historic Preservation Office, Kenneth Travous, Executive Director, and Lowell Observatory, Robert Millis, Director. The documentation was undertaken by the Historic American Buildings Survey (HABS) division of the National Park Service, Robert Kapsch, Chief, with Joseph Balachowski, Architect, and Catherine Lavoie, Historian, supervising. The project was completed in the summer of 1994 at Lowell Observatory, Flagstaff, Arizona. The recording team included Maggie Ross, team supervisor, Christina Radu, Schaeffer Somers, and Tom Hetrick, architect technicians, and Rebecca Jacobsen, historian. Rebecca Jacobsen conducted all research relating to the project and completed the historic structures reports, with Catherine Lavoie editing. Site photographs were taken by Brian Grogan.

Notes:

Andrew E. Douglass, letter to Percival Lowell, 27 November 1896, Archives, Lowell Observatory, Flagstaff, Arizona, Percival Lowell letters.

Platt Cline, Mountain Town (Flagstaff, Arizona: Northland Publishing, 1994), 167.

William Lowell Putnam, The Explorers of Mars Hill: A Centennial History of Lowell Observatory (West Kennebunk, Maine: Phoenix Publishing, 1994), 21.

Ibid., 268.

Cline, 167.

Ibid., 61.

Putnam, 25-6.

William Graves Hoyt, Lowell and Mars (Tucson: University of Arizona Press, 1976), 117.

Stanley Sykes, "A Diary of Floating the Dome," MS., Archives, Lowell Observatory, Flagstaff, Arizona, uncataloged papers, 1-5.

Putnam, 34.

Putnam, 76.

Stanley Sykes, "A Diary of Floating the Dome," MS., Archives, Lowell Observatory, Flagstaff, Arizona, uncataloged papers, 1-5.

Putnam, 130.

Ibid., 34.

Gerald McGlothlin, interview with the author, 1 July 1994.

Marian Card Donnelly, A Short History of Observatories (Eugene, Oregon: University of Oregon, 1973), 117.

Observatories turned to separate buildings for separate instruments as more was learned about the effects of structures on air quality, and therefore, observing quality.

Godrey Sykes, A Westerly Trend (Tucson: Arizona Pioneers Historical Society, 1944), 235-6.

Dr. Harry A. Butowsky, Astronomy and Astrophysics National Historic Landmark Theme Study (Washington, D.C.: National Park Service, 1989), 66 and 327.

Putnam, 21.

Sykes, 235.

Ibid.

Andrew E. Douglass, letter to Percival Lowell, 12 January 1895, Archives, Lowell Observatory, Flagataff, Arizona, Percival Lowell Letters.

Sykes, 235-6.

Putnam, 27.

Percival Lowell, letter to Andrew E. Douglass, 5 March 1895, Archives, Lowell Observatory, Flagstaff, Arizona, Percival Lowell Letters.

Sykes, 235.

Putnam, 19.

Andrew E. Douglass, letter to Percival Lowell, 14 January 1895, Archives, Lowell Observatory, Flagstaff, Arizona, Percival Lowell Letters.

Percival Lowell, letter to Andrew E. Douglass, 5 March 1895, Archives, Lowell Observatory, Flagstaff, Arizona, Percival Lowell Letters.

Hoyt, 52.

Putnam, 25.

Ibid., 27.

Sykes, 235

Putnam, 27.

Hoyt, 106.

Putnam, 28.

Putnam, 29.

Hoyt, 90.

Ibid., 55.

William Pickering, "Facts Pertaining to the Arizona Expedition." March 1, 1896, Archives, Lowell Observatory, Flagstaff, Arizona, uncataloged papers, 1.

Hoyt, 90.

Ibid, 108.

Spectrography is the study of the "spectral lines," or lines of color, produced by light sources.

Ibid., 117.

Putnam, 45-6.

Ibid. 43-4.

Photographic Collection, Lowell Observatory, Flagstaff, Arizona, Administration Building Vault, Album Number 1.

Andrew E. Douglass, letter to Percival Lowell, 15 May 1894, Archives, Lowell Observatory, Flagstaff, Arizona. Percival Lowell Letters.

Andrew E. Douglass, letter to Percival Lowell, 12 January 1895, Archives, Lowell Observatory, Flagstaff, Arizona, Percival Lowell Letters.

Donnelly, 113-114.

Andrew E. Dougalss, letter to Percival Lowell, 12 January 1895, Archives, Lowell Observatory, Flagstaff, Arizona, Percival Lowell Letters.

Stanley Sykes, "A Diary of Floating the Dome," MS., Archives, Lowell Observatory, Flagstaff, Arizona, uncataloged papers, 2.

Ibid.

Ibid.

Photographic Collection, Lowell Observatory, Flagstaff, Arizona, Administration Building Vault, Album Number 1. This photograph is reproduced in The Explorers of Mars Hill, by William Lowell Putnam, page 50.

Kathy Kramer, guided tour given to author, 31 May 1994.

Putnam, 44.

Hoyt, 129.

Ibid., 278.

Putnam, 147.

Ibid., 34.

Ibid., 137.

Ibid., 149.

Vesto Melvin Slipher, letter to Roger Lowell Putnam, 3 December 1927, Archives, Lowell Observatory, Flagstaff, Arizona, Vesto Melvin Slipher Letters.

Robert Millis, interview with author, 16 July 1994.

Ibid.

Gerald McGlothlin, interview with author, 10 July, 1994.

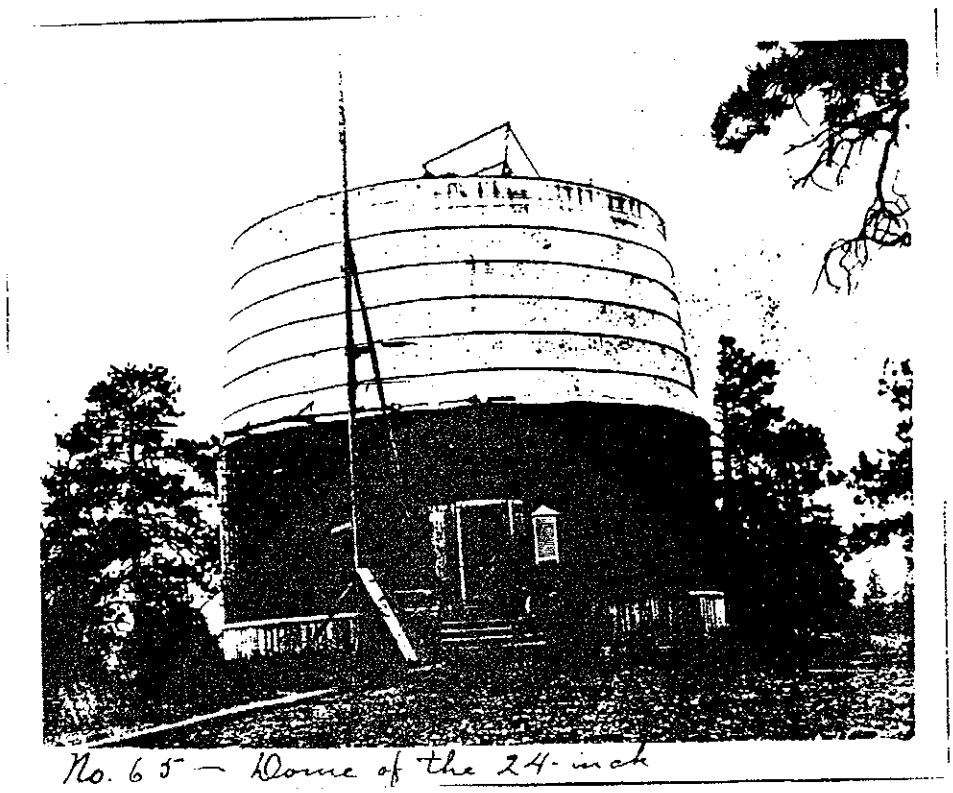

Figure #1 Photograph. Lowell Observatory Clark Dome. Archives, Lowell Observatory, Flagstaff, Arizona, ca. 1897.

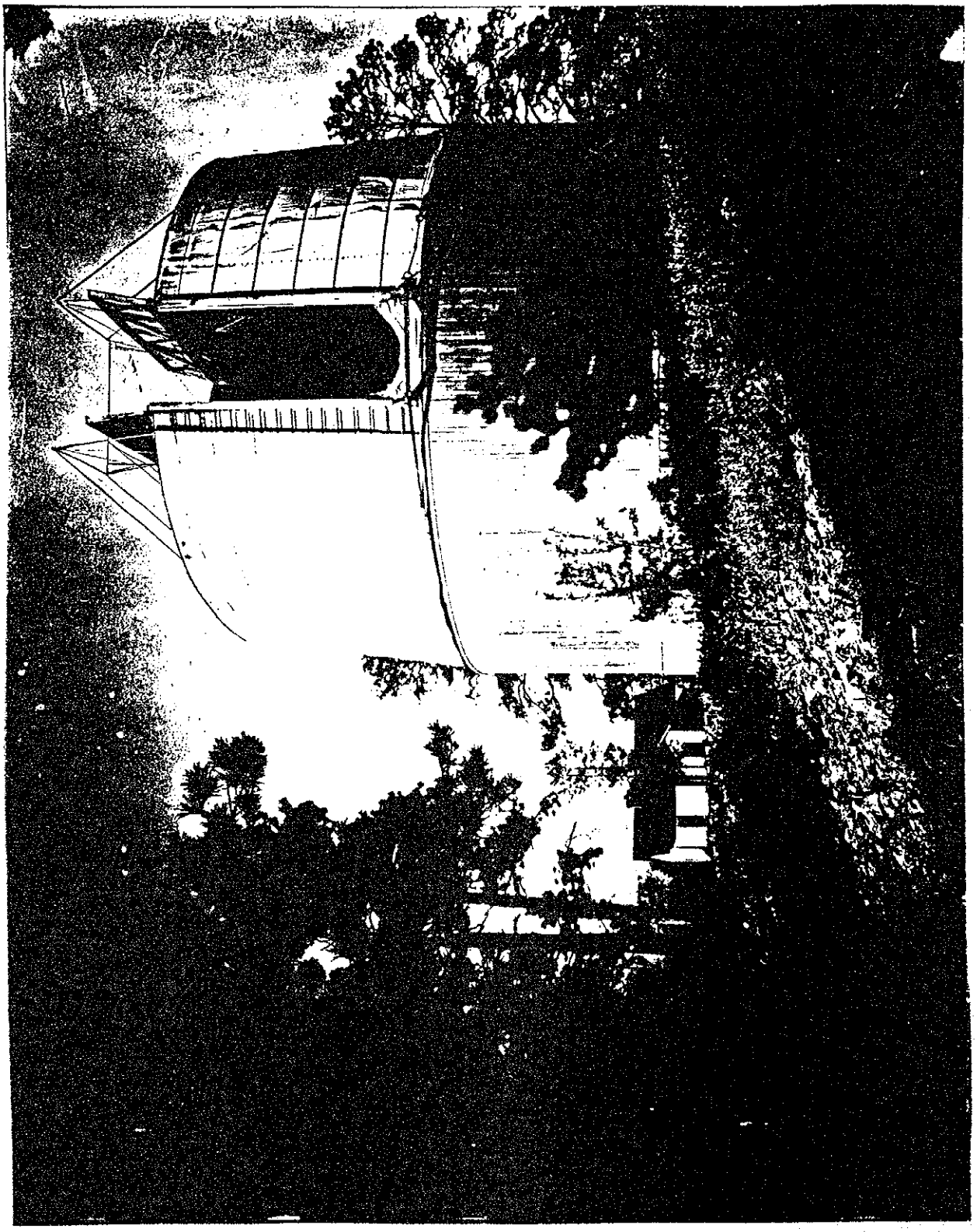

Figure #2 Photograph, Lowell Observatory Clark Dome. Archives, Lowell Observatory, Flagstaff, Arizona, ca. 1900.

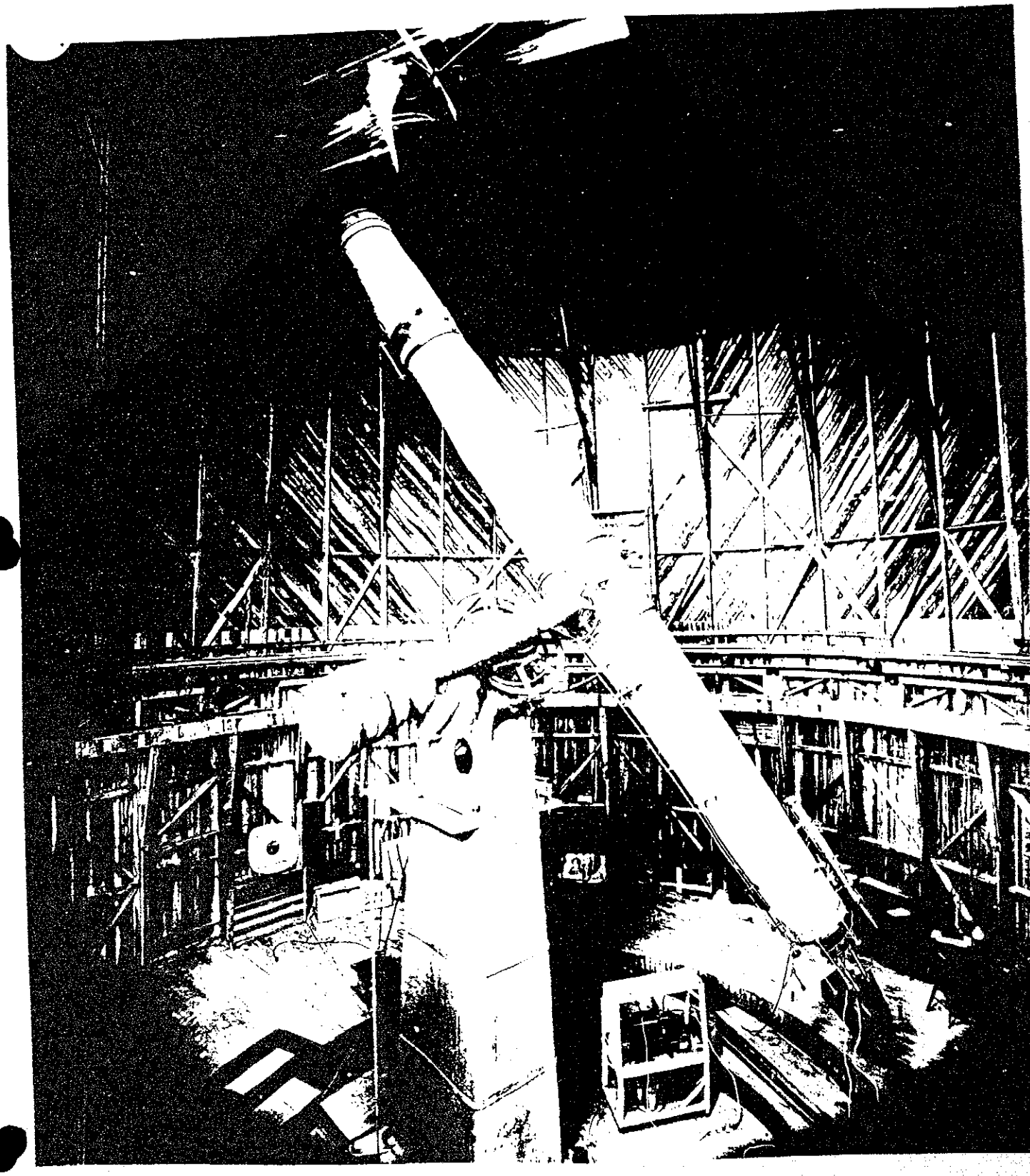

Figure #3 Photograph, Lowell Observatory Clark Dome interior, 24-inch Clark refracting telescope with Brashear specrograph. Archives, Lowell Observatory, Flagstaff, Arizona. ca. 1905.